기 계 진 동 학 도전문제 (제4장,기타)

출처 및 해답 [수업지정도서 (중앙도서관 5층 디지털미디어룸 내)]

[1] S. G. Kelly, Fundamentals of Mechanical Vibrations, 2nd ed., McGraw-Hill, 2000.
[2] L. Meirovitch, Fundamentals of Vibrations, McGraw-Hill, 2001.
[3] 이시복 등 8인 공역, 기계진동학, 제6판, 퍼스트북, 2019.
(원서 : S. S. Rao, Mechanical Vibrations, Prentice Hall, 2017.)

4.1 2자유도 모델 [2] Ex. 5.2

Example 5.2 Pitching motion of an Automobile

Consider the simplified model of an automobile shown in Fig. 5.5, let the parameters have the values m = 1,500 kg, I_C = 2,000 kg m^2, k_1 = 36,000 N/m, k_2 = 40,000 N/m, a = 1.3 m and b = 1.7 m, calculate the natural modes of the system and write an expression for the response.

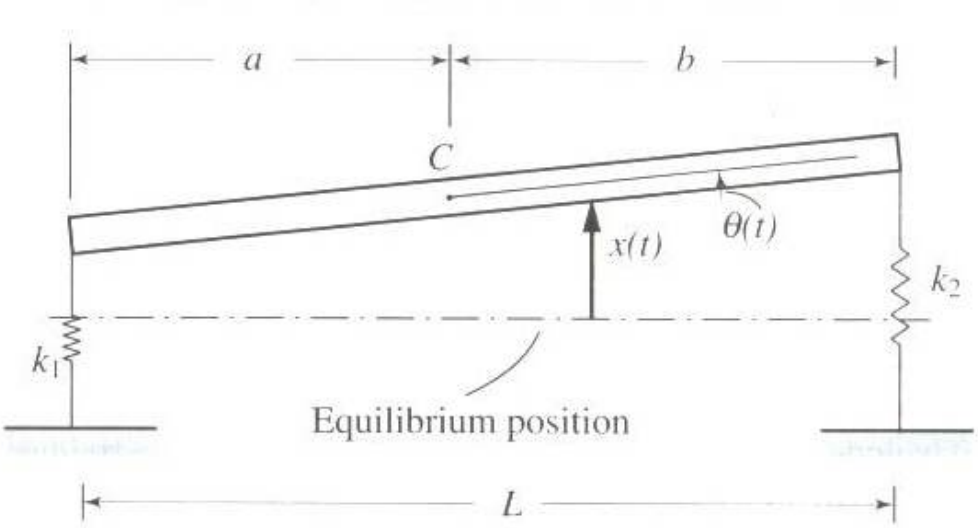

FIGURE 5.5
Simplified model of an automobile

EXAMPLE 5.8 Steady-State Response of a Spring-Mass System

Find the steady-state response of the system shown in Fig. 5.15 when the mass m_1 is excited by the force $F_1(t) = F_{10}\cos\omega t$. Also, plot its frequency response curve.

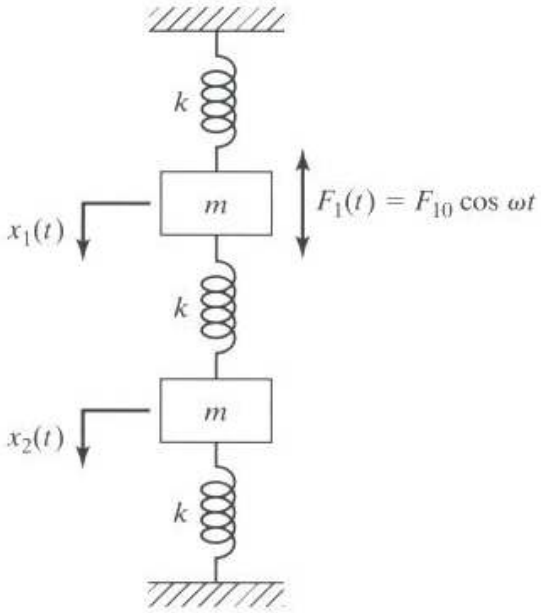

FIGURE 5.15 A two-mass system subjected to harmonic force.

EXAMPLE 2.14 Shock Absorber for a Motorcycle

An underdamped shock absorber is to be designed for a motorcycle of mass 200 kg (Fig. 2.30a). When the shock absorber is subjected to an initial vertical velocity due to a road bump, the resulting displacement-time curve is to be as indicated in Fig. 2.30(b). Find the necessary stiffness and damping constants of the shock absorber if the damped period of vibration is to be 2 s and the amplitude x_1 is to be reduced to one-fourth in one half cycle (i.e., $x_{1.5} = x_1/4$). Also find the minimum initial velocity that leads to a maximum displacement of 250 mm.

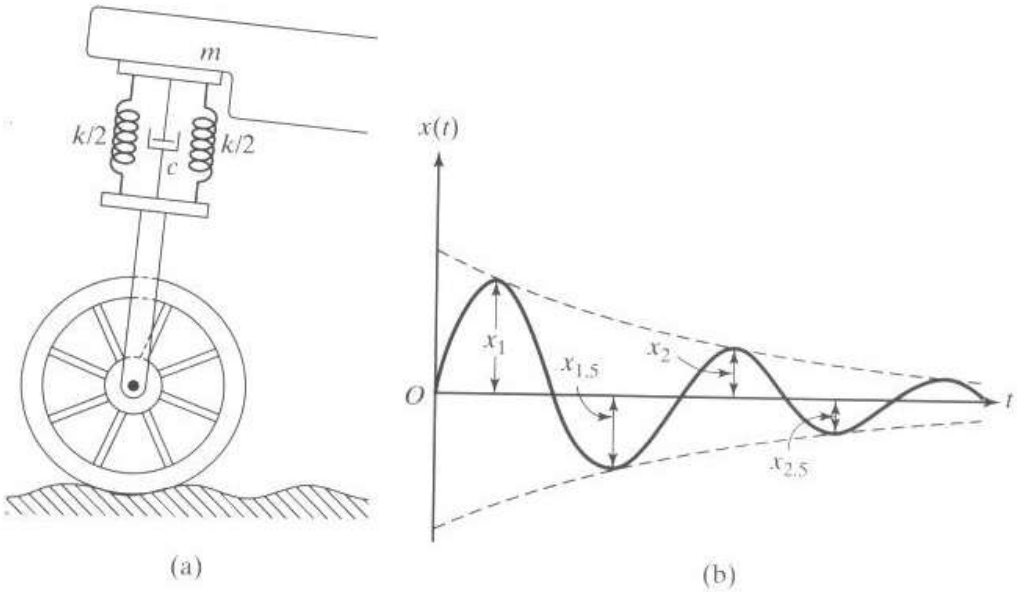

FIGURE 2.30 Shock absorber of a motorcycle.

정 답

4.1 2자유도 모델 [2] Example 5.2

$\omega_1 = 6.86$ rad/s $\omega_2 = 9.58$ rad/s

$$\mathbf{u}_1 = \begin{Bmatrix} X_1 \\ \Theta_1 \end{Bmatrix} = \begin{Bmatrix} 1 \\ -0.257 \end{Bmatrix} \qquad \mathbf{u}_2 = \begin{Bmatrix} X_2 \\ \Theta_2 \end{Bmatrix} = \begin{Bmatrix} 0.343 \\ 1 \end{Bmatrix}$$

$$\mathbf{x}(t) = C_1 \cos(6.86t - \phi_1) \begin{Bmatrix} 1 \\ -0.257 \end{Bmatrix} + C_2 \cos(9.58t - \phi_2) \begin{Bmatrix} 0.343 \\ 1 \end{Bmatrix}$$

5.3 진동 흡진기 [3] Example 5.8

$x_1(t) = X_1 \cos\omega t$ $x_2(t) = X_2 \cos\omega t$

$$X_1 = \frac{(2\omega_1^2 - \omega^2)(F_{10}/m)}{(\omega_2^2 - \omega^2)(\omega_1^2 - \omega^2)} \qquad X_2 = \frac{(F_{10}/m)}{(\omega_2^2 - \omega^2)(\omega_1^2 - \omega^2)}$$

$\omega_1 = \sqrt{k/m}$ $\omega_2 = \sqrt{3k/m}$

1.6 질량, 감쇠 강성 측정 [3] Example 2.14

$k = 2{,}360$ N/m, $c = 554$ N·s/m, $\dot{x}_0 = 1.429$ m/s